Advances in Ground-Based GPS Meteorology

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Introduction

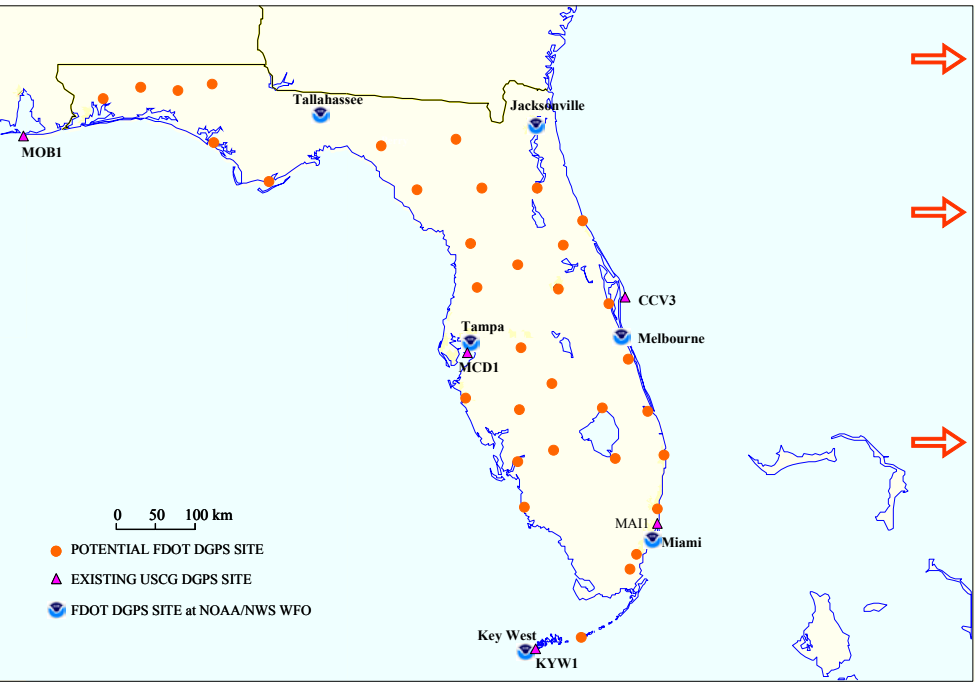
- In 1997, we presented a talk at the 22nd Annual NWA meeting in Reno on the impact of GPS water vapor measurements on weather forecast models.
- We described how GPS could be used to retrieve total column (integrated) precipitable water from signal delays caused by changes in refractivity associated with temperature, pressure, and water vapor in the lower atmosphere.
- We demonstrated that GPS IPW retrieval accuracy was comparable to rawinsonde measurements but with much higher temporal resolution.
- We discussed how GPS observations might be assimilated into an operational weather model.

GPS-Met Status

- Since then, GPS-Met data acquisition and processing techniques have been refined to the point where they can (or soon will) be used operationally by Met Agencies worldwide.
- Techniques to reduce the latency of GPS-Met retrievals from 36 hours to less than 20 minutes without significantly affecting IPW retrieval accuracy have been implemented.
- GPS-Met retrievals are now available via NWSTG and LDAD. AWIPS GPS-Met display modules are under development at FSL and several WFO's.
- NWP impact assessments (data denial experiments) demonstrate a positive impact on moisture & precipitation forecasts that is strongly related to network size.

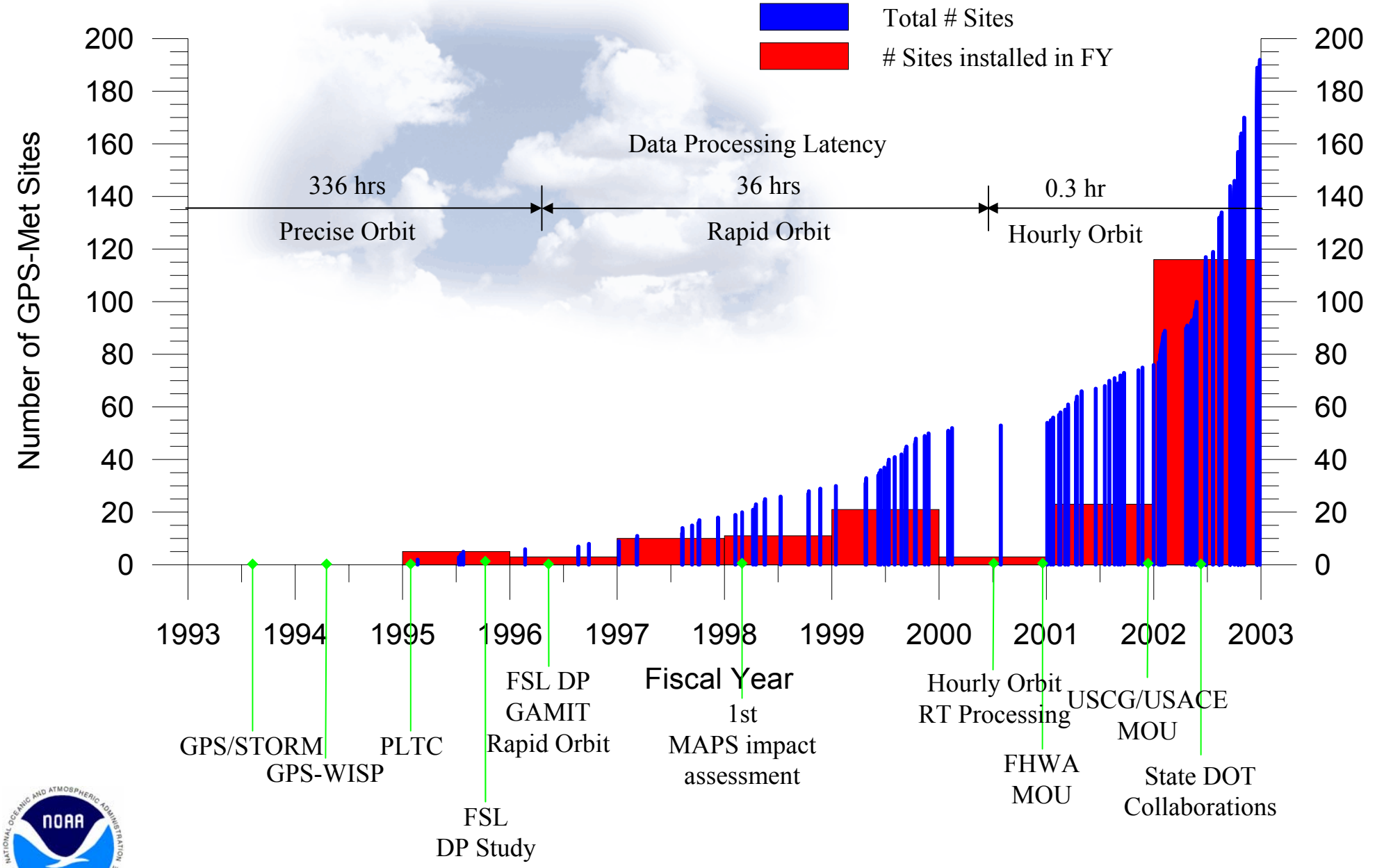
GPS-Met Parterships

- GPS-Met systems are now located at 6 WFO's: Seattle, Salt Lake, Denver/Boulder, Blacksburg, Jacksonville, and Tallahassee.
- Collaborations with state departments of transportation including Michigan, Ohio, North Carolina, Texas, Louisiana and Florida, are allowing us to expand GPS-Met coverage with little impact or cost to the states and NOAA.

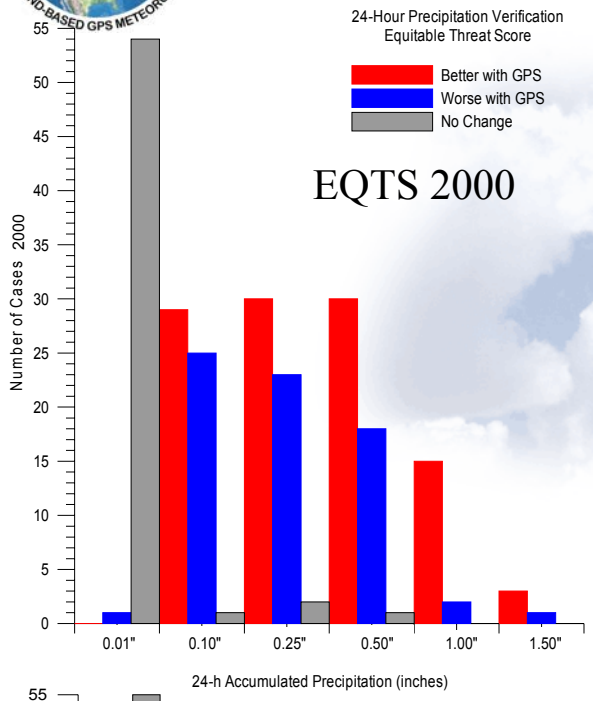


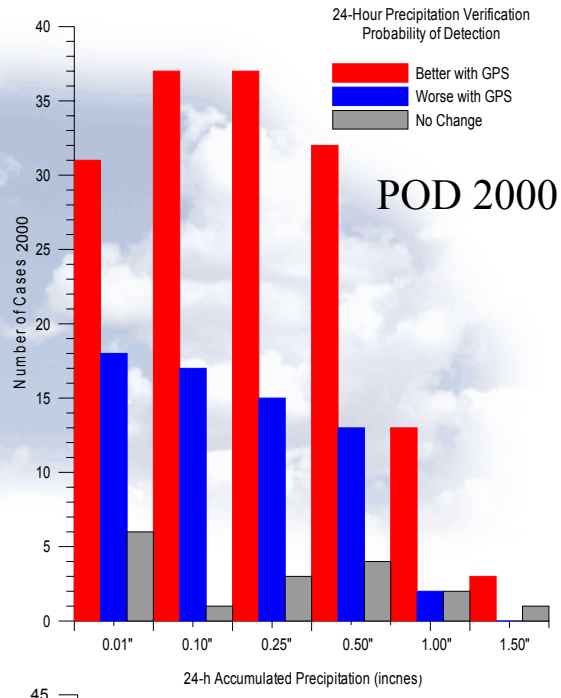
FDOT now provides data from 7 sites with more than 40 planned; ***NWS WFO's*** are assisting FDOT with siting and logistics, SOO's & forecasters are evaluating the data; ***FSL*** is processing and distributing the data, & working with the WFO's to assess the results.

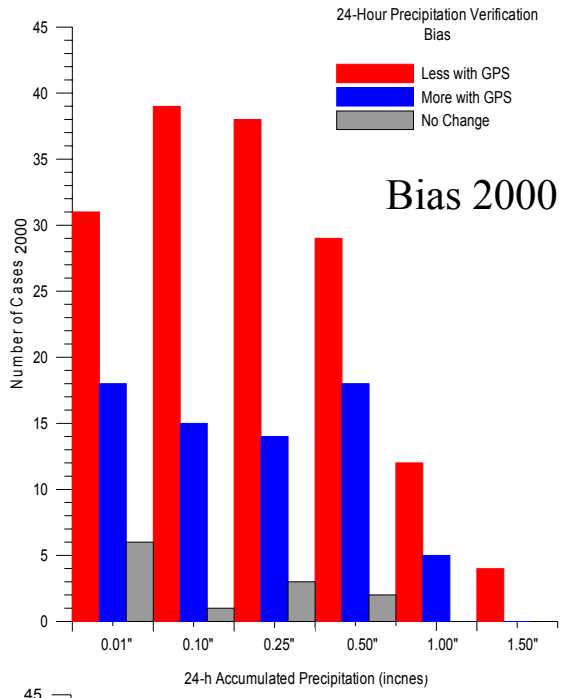
History, Evolution & Critical Decisions

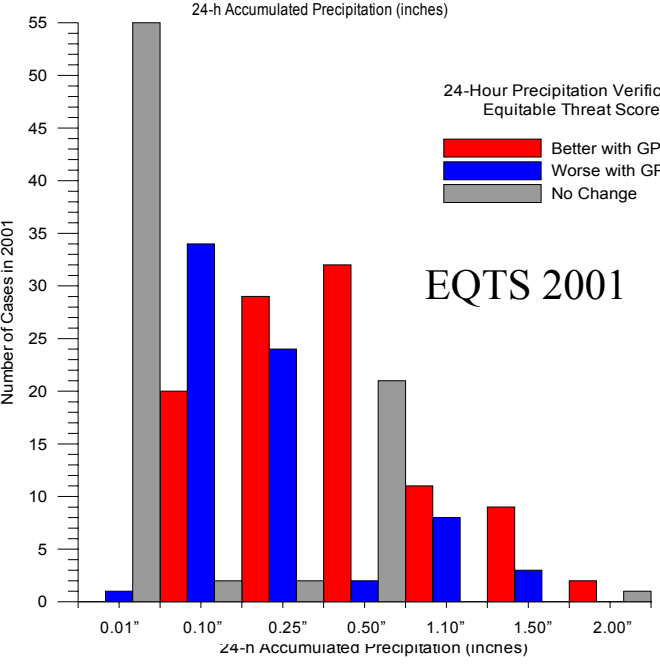


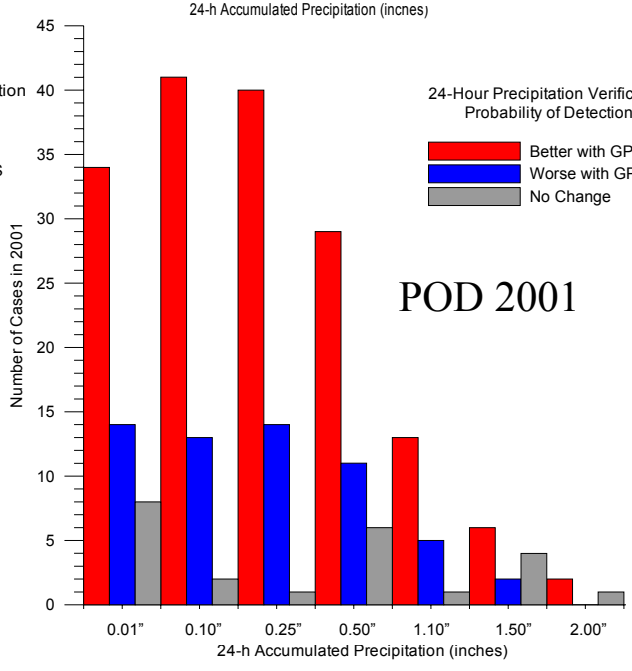
24-hour Precipitation Verification

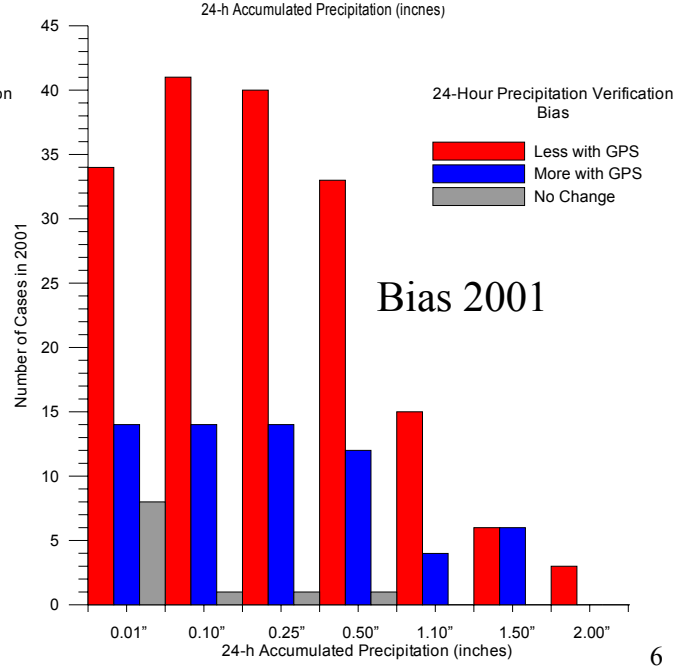




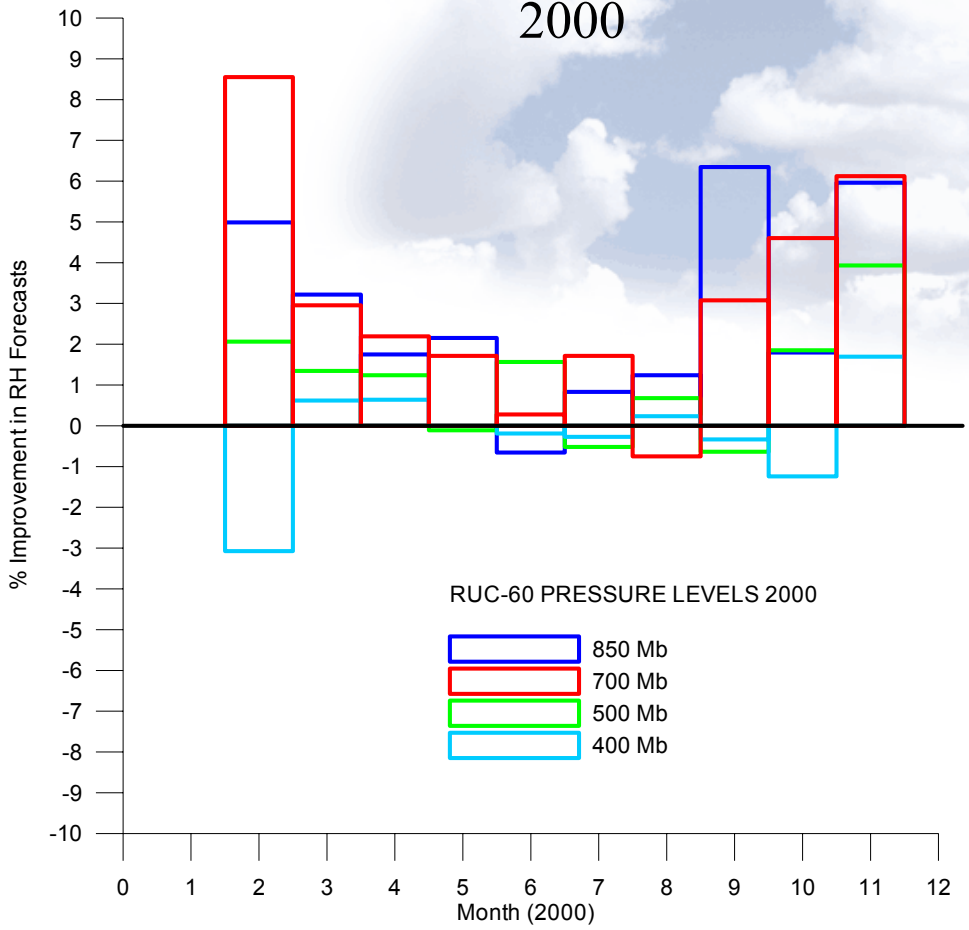




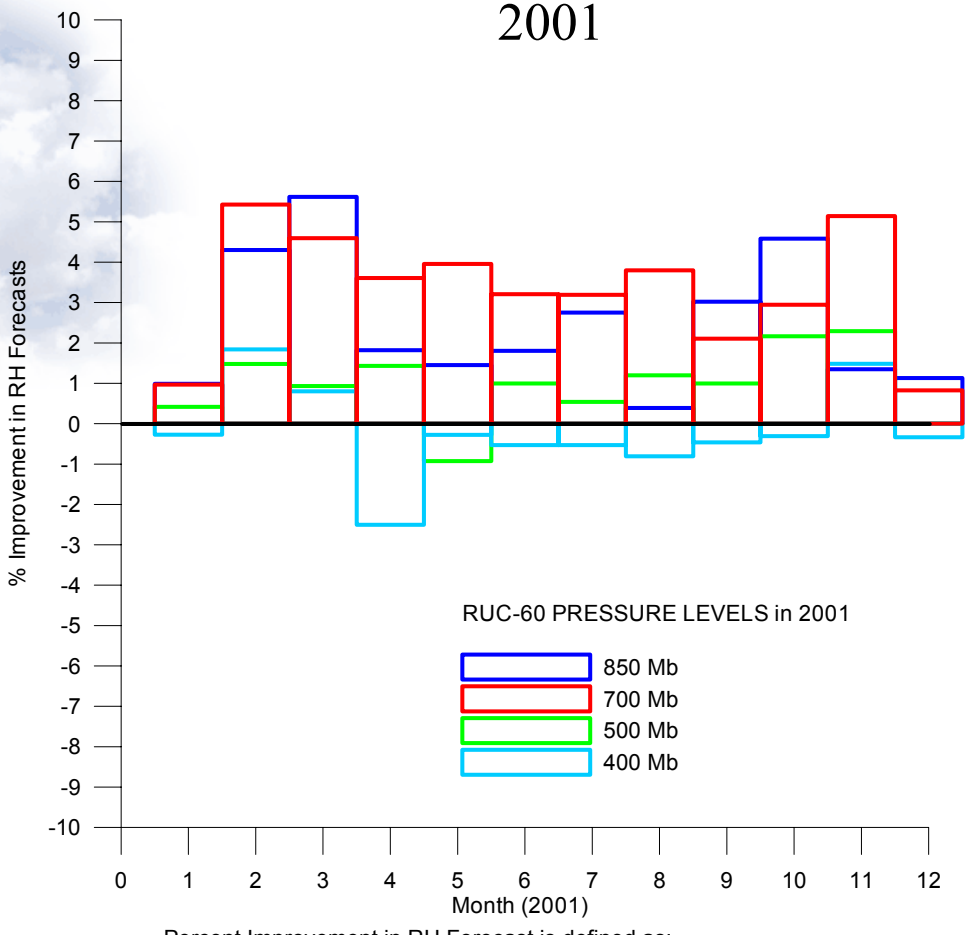




GPS Impact by Month & Level on RUC60 3h RH Forecasts



Percent Improvement in RH Forecast is defined as:
1-(3 h RH Forecast Error with GPS/3 h RH Forecast Error w/o GPS)*100



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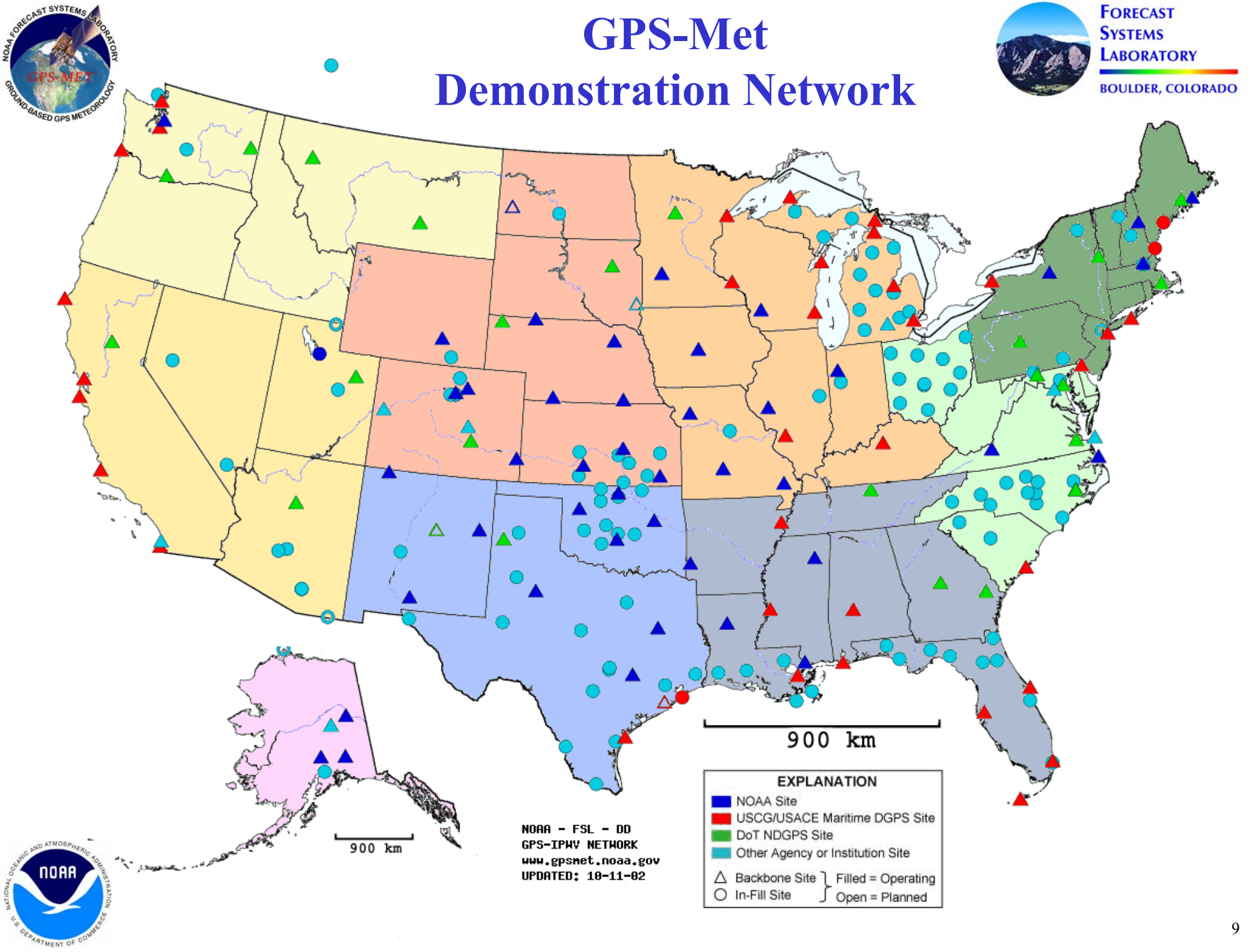
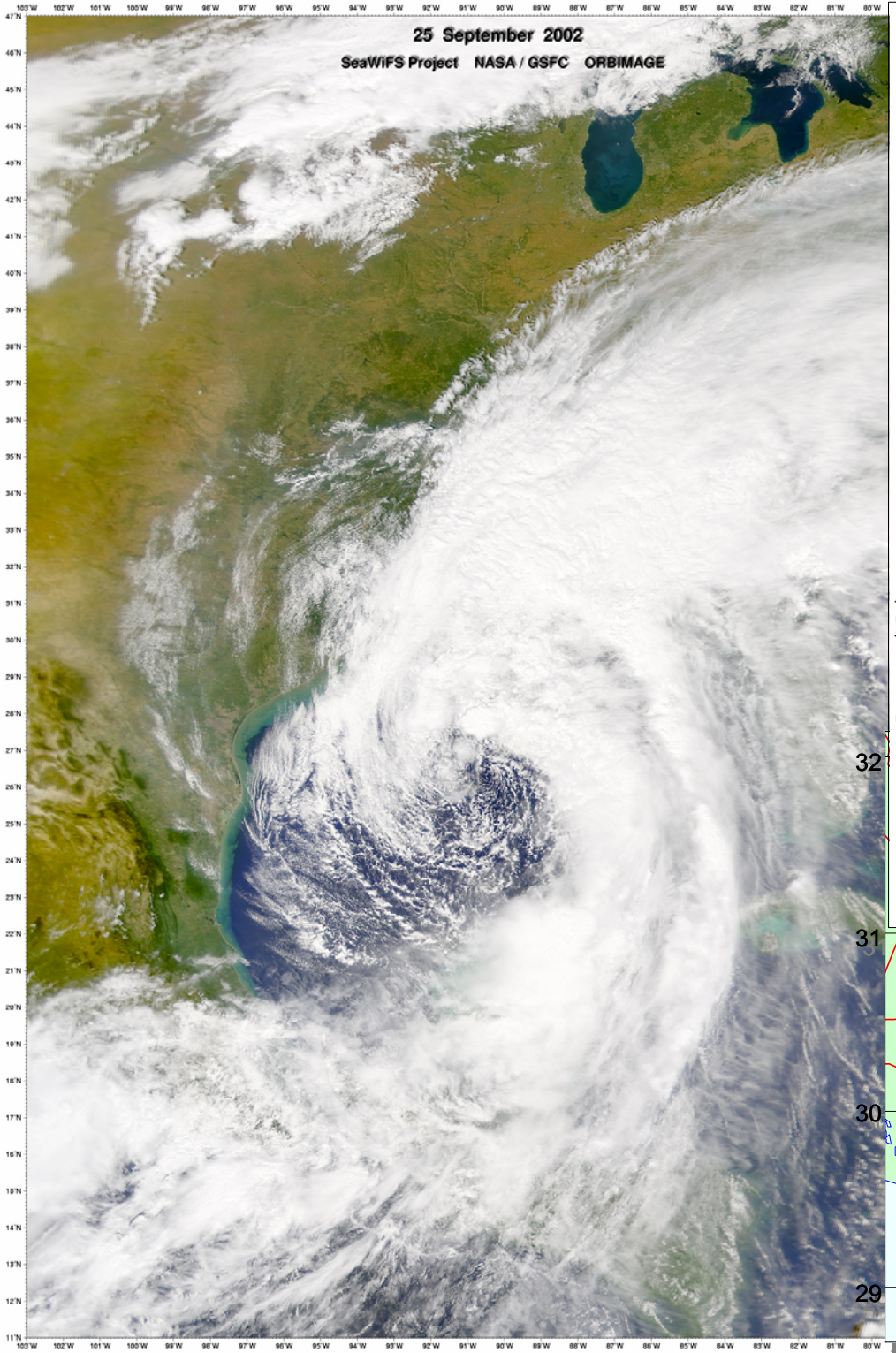
Summary of Results (1998-2002) RUC60 GPS Impact Tests

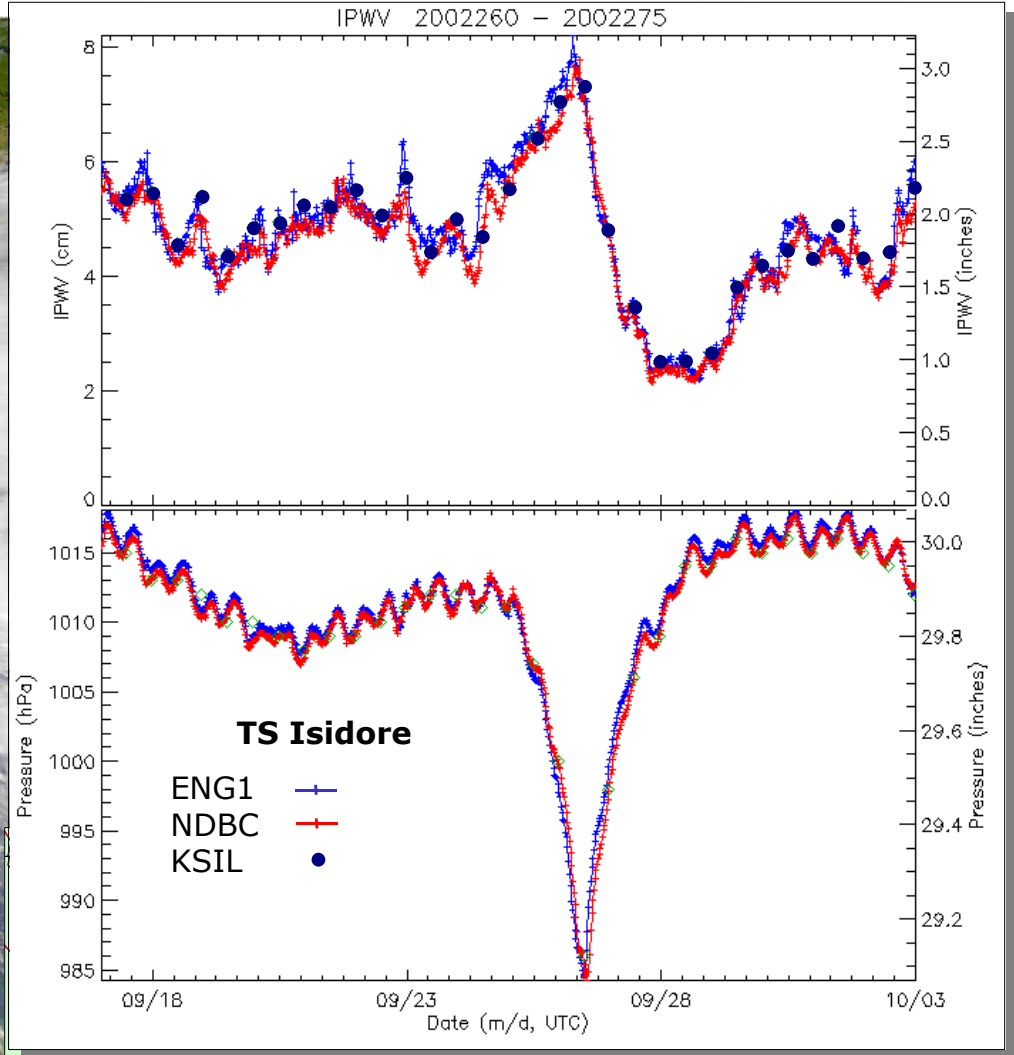
No. Sta	18	56	67	100+
Level	1998-99	2000	2001	2002
	% improvement (normalized by total error)			
850	1.5	3.8	3.9	7.2
700	1.1	4.1	6.3	6.6
500	0.7	2.1	2.0	0.0
400	0.3	0.1	-0.4	-1.9
Mean	0.9	2.5	2.9	3.0

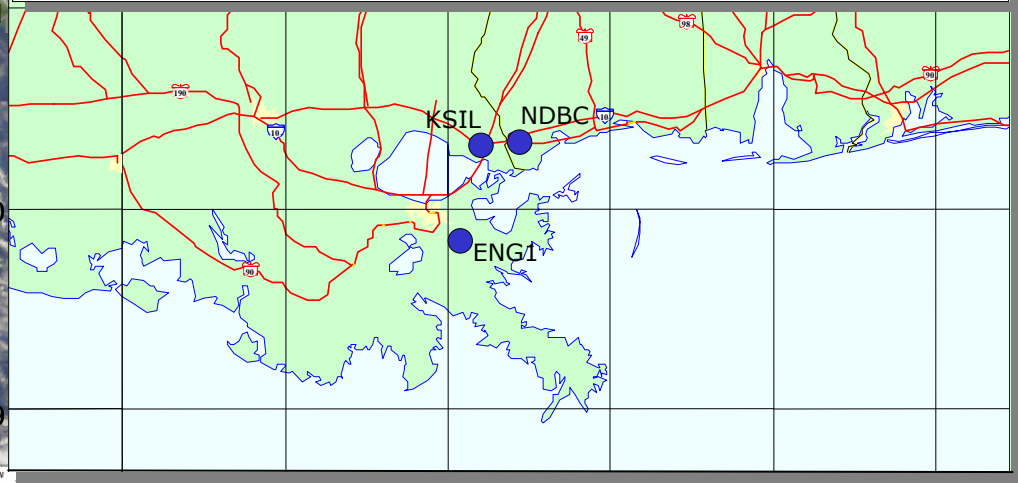
- Multi-year study with the 60km RUC indicates that GPS-Met makes a small but consistent positive impact on short-term weather forecast accuracy:
  - primarily at the lower levels where most of the moisture resides - IPW more correlated w/*low*-level moisture
  - magnitude of impact consistently increases with the number of stations
  - impact on precipitation forecast accuracy generally increases with precip amount threshold
  - RH forecast accuracy is greatest in the cool months when convection is less frequent and the moisture distribution is correspondingly less spotty.

GPS-Met Demonstration Network

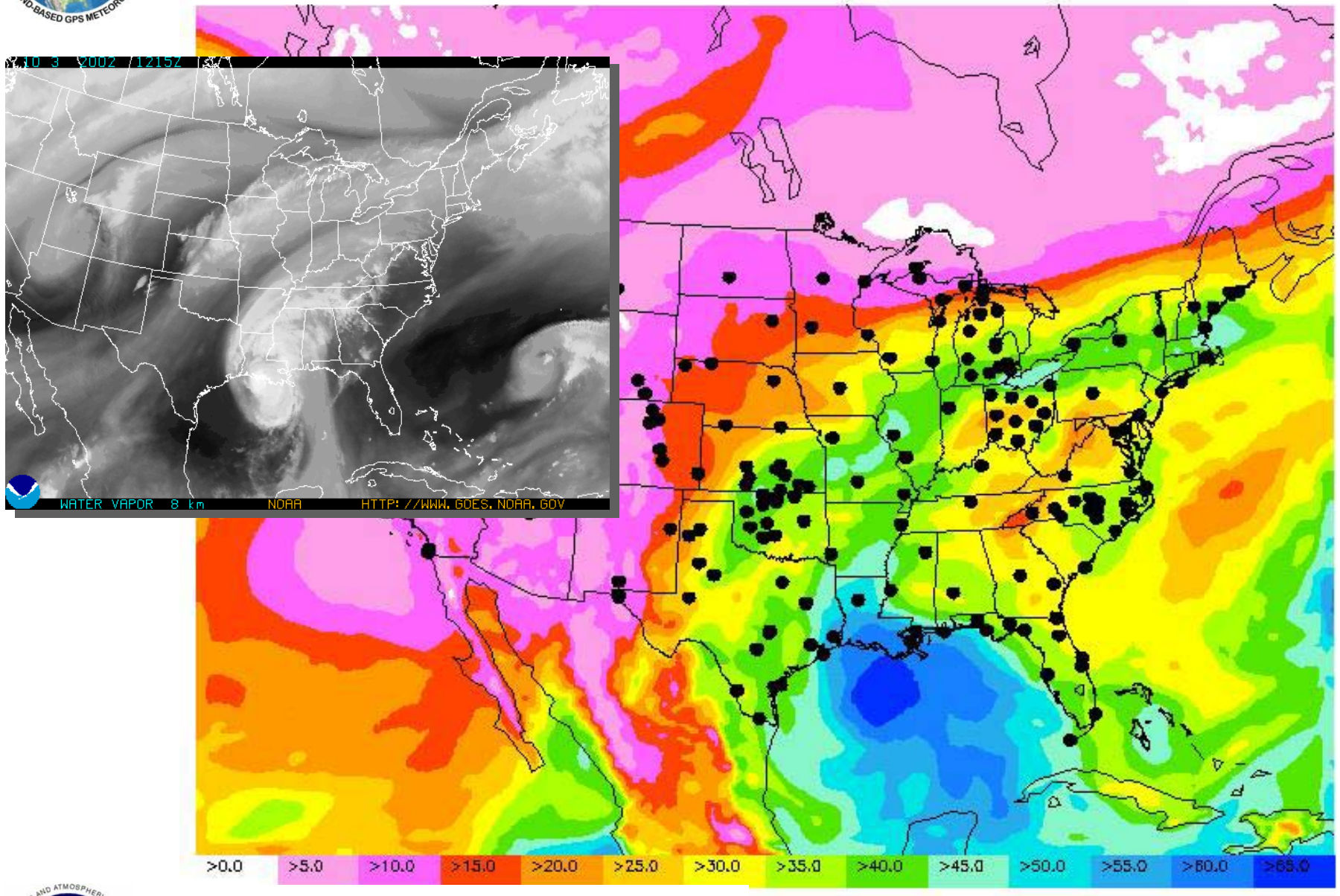



25 September 2002
SeaWiFS Project NASA / GSFC ORBIMAGE


IPWV 2002260 – 2002275
IPWV (cm)
IPWV (inches)
Pressure (hPa)
Pressure (inches)
TS Isidore
ENG1
NDBC
KSIL
09/18
09/23
09/28
10/03
Date (m/d, UTC)


KSIL
NDBC
ENG1

Hurricane Lilly 3-Oct-02



FSL RUC 20 w/ GPS-IPW

Total Column PW (mm) 1-h Forecast Valid: 03-Oct-02 06:00 UTC

NOAA Forecast Systems Laboratory

Ground-Based GPS Meteorology

For More Information Contact
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